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DOES MENTAL ESTIMATION OF FORWARD REACH DISTANCE REFLECT FORWARD REACH ABILITY IN ELDERLY?

Aravind Balasubramanian[1], Rajeswari Muthusamy[2*], Sivakumar Ramachandran[3]

[1]Post graduate student, Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research.
[2*]Professor, Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research,
[3]Professor, Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research.
*Corresponding Author: Dr. Rajeswari Muthusamy, Email ID: rajeswari@sriramachandra.edu.in

ABSTRACT

Background: Cognitive planning is one of the essential component to estimate distance to perform a functional task without losing balance. Anticipatory reach is the ability of an individual to estimate their reach distance while planning to perform the task. Such planning is likely to decline with aging predisposing to falls. The relationship between anticipatory reach and actual reach is not evident from the literature.

Aim: To study the relation between anticipated reach distance and actual reach performed in eyes open and closed condition among young and elderly.

Methodology: Younger and elderly population were recruited as participants who were asked to estimate their forward reach as a number from inch tape mounted horizontally on the wall. The participants were asked to perform forward reach with eyes open and eyes closed. Three trials were performed. The maximum distance of the three trials were used for the data analysis.

Result: Statistically significant difference was found between anticipatory reach and reaching with eyes open and between reaching with eyes open and eyes closed in elderly population, and no difference among the values found in younger participants.

Conclusion: Anticipatory reach distance was greater than actual reaching with eyes open in elderly population wherein minimal differences was found in younger population. Reaching distance tends to be decreased in eyes closed than eyes open in elderly population than younger population. Elderly population must be educated about their overestimation of anticipatory reach and to plan appropriate strategies to prevent falls.

KEYWORDS: Anticipatory reach, Balance, Fall, Vision, Elderly, Forward reach

INTRODUCTION

Aging is a global phenomenon and inevitable process and the advancement in medical and healthcare systems has increased the lifespan of elderly population. Postural stability or balance is maintained by both anticipatory and compensatory postural adjustments when the balance is disturbed. Forward reach is a common clinical measure of balance performance. This task requires moving the body's centre of mass toward the front edge of the base of support in a well-controlled manner, and thus is often regarded as an indicator of boundary of stability1. The forward reach test assesses the anticipatory postural adjustment ability of an individual. Reaching distance may decrease and thereby limits of stability decreases early in elderly population. Cognitive planning is the mental representation of an action without engaging in its actual execution and is one of the essential component of anticipatory postural adjustments 2,3. Cognitive planning exhibits scaling of movement time to distance, speed–accuracy trade off, biomechanical constraints and the pattern of simulated effort 4. In real life scenarios such planning is essential for motor performances without a fall.

Fall risk can be decreased by having the foresight and capacity to swiftly integrate visual clues for the right reaction such as reach for the support to maintain balance when disturbed. Cognitive planning is assumed to reflect the ability of the individual's performance in specific environment. There is contradicting evidence between the anticipatory reach and actual reach in elderly with one research finding that anticipatory reach was lesser than actual reach in the elderly population and another study finding the opposite respectively 5,6. In this study, we intended to test whether anticipatory reach (AR) distance reflected their ability to perform forward reach and whether individuals rely on anticipatory reach distance for reaching when reaching is performed without vision. This part of testing can provide insight into forward reach done in low light settings or with vision compromise. We compared the difference in ability to predict a forward reach distance and actual performance among young and elderly subjects, to understand the effect of age on these aspects.

METHODOLOGY

The study was approved by the Institutional Ethics committee (reference - CSP/23/APR/127/366). Participants were recruited from the community and outpatient department of Physiotherapy and students of Faculty of Physiotherapy. The

younger population of age 20 – 25 years were screened for inclusion into the study. The elderly population of age 65 – 75 years, who can walk outdoors, able to raise both the upper limb by 90 degree and have corrected vision and hearing were included in the study. In both age groups participants with Orthopaedic or neurological disabilities and musculoskeletal problems of upper limb during daily activities were excludes from the study.

Selected participants were included in the study after obtaining the informed consent. A n inch tape measure was mounted on the right-side wall which extended horizontally at the height of the participant's acromion. The height of the inch tape was adjusted according to participants acromion process level. The procedure of forward reach test was explained to the participant. The participants were asked to estimate their reach distance as a number along the tape measure where their knuckle would reach when the arm is fully extended and the trunk is bent forward followed by reaching with eyes open (REO) and reaching with eyes closed (REC) without moving their feet or losing balance. At the starting and ending points of the reach, markers was fixed and the difference between the initial position of the knuckle and final position of the knuckle after reaching was measured as the distance reached. The maximum reach of three trials were included for data analysis.

Figure 1: Forward reaching initial and ending position

RESULTS

This observational study included the sample size of 30 younger (10 male/20 female) and 30 elderly population (13 male/17 female). The mean age was 22.5 years and 68.73 years for younger and elderly population respectively. ANOVA was used to find the difference between anticipatory reach, reaching with eyes open and reaching with eyes closed among younger and elderly participants which was statistically significant in elderly population (Table 1). Post hoc analysis of the difference between anticipatory reach and reaching with eyes open and anticipatory and reaching with eyes closed were statistically significant in elderly population (Table 2). Unpaired t test was used to find the difference between anticipatory reach and reaching with eyes open between the younger and elderly population which showed statistically significant with $p<0.05$ (Table 3).

TABLE 1: COMPARISION OF DIFFERENCE BETWEEN THE AR, REO AND REC IN YOUNGER AND ELDERLY POPULATION

	AR (SD) cm	REO (SD) cm	REC (SD) cm	p VALUE
YOUNGER (n = 30)	41.46 (5.30)	41.26 (4.79)	40.80 (4.08)	0.74
ELDERLY (n = 30)	30.1 (7.16)	24.46(6.52)	21.33(5.04)	<0.001*

ANOVA with $p<0.05$; AR- Anticipatory Reach; REO – Reaching with Eyes Open; REC – Reaching with Eyes Closed.

TABLE 2: POST HOC ANALYSIS OF DIFFERENCE BETWEEN THE AR, REO AND REC IN YOUNGER AND ELDERLY POPULATION

	YOUNGER (n = 30)	p VALUE	ELDERLY (n = 30)	p VALUE
AR – REO (cm)	0.20	0.98	5.63	0.002*
AR – REC (cm)	0.66	0.85	8.76	<0.001*
REO – REC (cm)	0.46	0.92	3.13	0.137

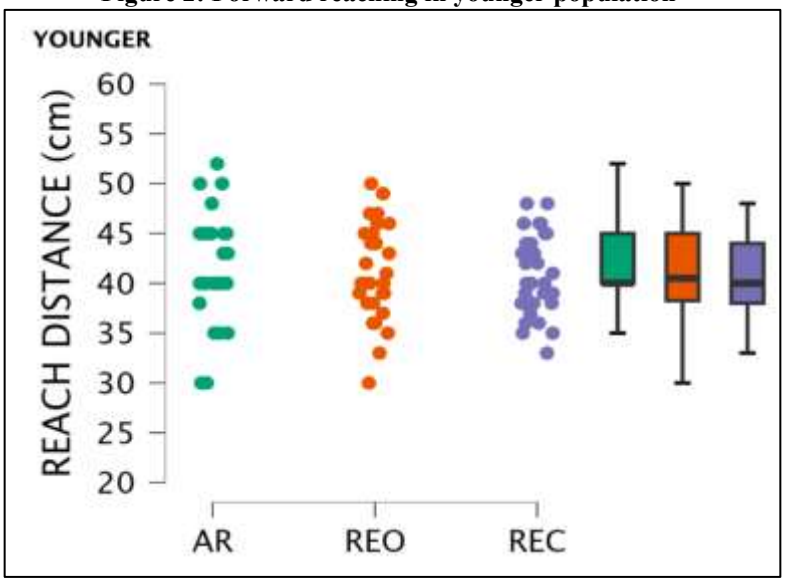
Post hoc test with $p<0.05$; AR- Anticipatory Reach; REO – Reaching with Eyes Open; REC – Reaching with Eyes Closed

TABLE 3: DIFFERENCE OF AR AND REO IN YOUNGER AND ELDERLY POPULATION

	MEAN (SD)	p VALUE
YOUNGER (n = 30)	2.75 (2.87)	0.01*
ELDERLY (n = 30)	8.00 (3.50)	

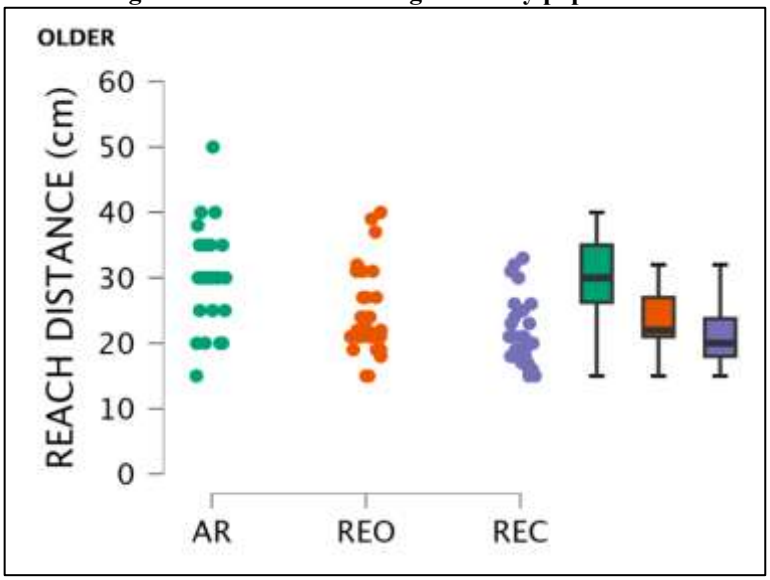
Unpaired t test with $p<0.05$; REO – Reaching with Eyes Open; AR- Anticipatory Reach

Figure 2: Forward reaching in younger population



AR – Anticipatory Reach; REO – Reaching with Eyes Open; REC – Reaching with Eyes closed

Figure 3: Forward reaching in elderly population



AR – Anticipatory Reach; REO – Reaching with Eyes Open; REC – Reaching with Eyes closed

DISCUSSION

In this study, we found that elderly population overestimate their reach distance than they could do in REO and the reaching distance with eyes closed was lesser than eyes open. The AR was found to be increased than actual reach in elderly population wherein there was a minimal difference been found in younger population. This finding is in contradiction with the study done by Cordova and Gabbard et al (2014) where the elderly population underestimated the reaching distance and the younger population did overestimate the reaching distance 5. Decline in hip joint movement could have resulted in larger discrepancy between actual and perceived maximum reach position which is similar to the study done by Atushi okimoto et., al (2017). Elderly population may overestimate their ability as they are likely to retain the mental models of hip motions that they initially created when they were younger, and their overall balance techniques are not likely to limit or decrease hip mobility in any manner 6.

The over estimation of ability to reach could be seen as an issue that might lead to a fall. Terasa liu Ambrose et al at 2008 found that elderly population are unaware of their neuromuscular limitations. As a result, they increase their risk of falling by planning and carrying out movements that cause loss of balance by overestimating their abilities, or they may choose to stay inactive to prevent opportunities for the loss of balance, reducing physiologic function, such as underestimating their abilities 7.

Vision plays a major role in elderly population in postural control which is evident by the decreased forward reach with absence of visual cues in elderly population than younger population. In elderly population, standing balance appears to

be diminished because the compromise in vision adversely affects the vestibular system due to poor or absent visual feedback such as poor lightning area at night, which could increase the fall risk while going for bathroom or having a glass of water. These individual uses proprioception to maintain balance 8 9. In our study the reaching distance with eyes closed was lesser than the REO in elderly population which indicates that elderly populations are not relying on AR when the vision is removed. In our study, we did not specifically explore somatosensory problem of the participants which could be a limitation. If somatosensory deficits existed, cognitive dependency might be present which should be studied in the future.

The difference in anticipatory and actual reach among elderly population was higher compared to the younger population where there was only a minimal difference. Elderly population tends to overestimate their reaching distance and younger population underestimate their reaching distance. Elderly population who has decreased forward reach tends to overestimate their reach despite having poor physical ability which increases with aging 10. Stockel T et al 2017 postulated that the deficit in anticipatory motor planning abilities in elderly population was associated with declines in cognitive skills due to decrease in prefrontal cortex grey matter volume. Younger population tends to underestimate their reaching distance for self-protection against accidents such as fall despite having a good physical ability 11.

CONCLUSION

Anticipatory reach was found to be increased than reaching with eyes open in elderly population wherein minimal differences was found in younger population. Reaching distance tends to be decreased in eyes closed than eyes open in elderly population than younger population. Elderly population must be educated about their overestimation of anticipatory reach and to plan appropriate strategies to prevent falls.

Conflict of Interest

No conflict of interest attached to this study.

Ethics Approval

Approval obtained from IEC, SRIHER. REF: CSP/23/APR/127/366.

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